Asteroid Sampling and Trajectory Redirect Attempt (ASTRA)

Communications Overview

AE 427

Spacecraft Preliminary Design

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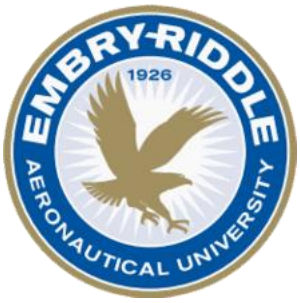

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Communications Overview

The X-band will be utilized for our project. On top of this, for the link budget, attenuation is most likely not required, and the free space losses will be 162 dB at 29*10^6 km. Cable and connector losses will also be considered when determining the budget. The license will cost about $150,000 per license according to the CSSMA, but this is based on a satellite with a lifetime of 3 years. There will also be an application fee of $30,000. The bandwidth will be about 914 kbits/s. The data rate is presented in the table below:

Data Rate Requirements of Instrumentation	
Instrumentation	**Data Throughput (kbit/s)**
OCAMS	300
OVIRS	200
OTES	100
REXIS	150
OLA	80
TAGSAM	84
Total	914

Figure 1: OSIRIS-Rex Instrumentation

The data will be transmitted by utilizing the Small Deep Space Transponder. The size of the spacecraft we are transmitting will be based on the OSIRIS-Rex. However, for the power source, it will range from 50 watts and end around 20.65 Watts.

Our ground system will be integrated within NASA's Space Communications and Navigation (SCaN) infrastructure to have an effective Command and Control (C2) node and data uplink. The newly upgraded launch communications segment (LCS) will be used. This ground system comprises the Kennedy Uplink Station and the Ponce de Leon Station in Cape Canaveral and New Smyrna Beach, respectively. These uplink stations part of the Near-Earth Network (NEN) will provide primary communication capabilities during spacecraft pre-launch, launch, and ascent. Each station is equipped with a 6.1-meter antenna that can simultaneously transmit and receive S-band signals.

Communications Mission Overview

Once ASTRA has reached a parking LEO, uplink and downlink communications will be transferred to NASA's Deep Space Network (DSN). DSN consists of three primary ground stations utilizing 44–70-meter antennas capable of planetary missions. DSN can receive and transmit using S, X, and Ka-band. DSN operations will be handled through JPL in Pasadena, California. For further redundancy and to prevent dropout, we will integrate the U.S. Space Force Satellite Control Network (SCN) to bounce and boost transmission signal. Liaisons from Space Delta 6 at Schriever Space Force Base, Colorado will flow command and control authority of ASTRA between USSF, JPL, and ASTRA MCC.

ASTRA Specifications

ASTRA will operate primarily on X band frequencies. An FCC license will be acquired for a frequency, preferably around 8.5 GHz. A bandwidth of 200kHZ will be used for increased data rate and will allow for simultaneous transmission along several frequencies centered around 8.5 GHz. Quadrature modulation will also be used to increase data throughput if necessary. ASTRA will use a 50-Watt transmitter to ensure signal integrity and strength, even at the mission's furthest point. A directional 1-meter dish transceiver antenna will be used for primary communications. The 1-meter antenna has an effective half-power angle of 1.8 degrees, giving ample error allowance for transmission.

Launch Communication Segment (LCS) Telemetry Characteristics	
Frequency	2200-2395 MHz
Data Rate	17.2 Kb/s
Bandwidth	+/- 500kHz
Effective Range	1500 km

Deep Space Network (DSN) Telemetry Characteristics	
Frequency	300MHz-26 GHz
Data Rate	4 Mb/s
Bandwidth	+/- 16GHz
Effective Range*	30000km+

*Note: DSN has had successful transmissions up to 156.97 AU

ASTRA Telemetry Characteristics	
Frequency (Transmit)**	8.5 GHz
Frequency (Receive)**	7.2 GHz
Data Rate	1Mbit/s
Bandwidth	200 kHz
Effective Range*	300,000,000 km

*Note: The range listed is the maximum range of transmission for reasonable signal integrity

**Note: The frequencies will be very close to this once an FCC license is granted

Astra Simplified Link Diagram

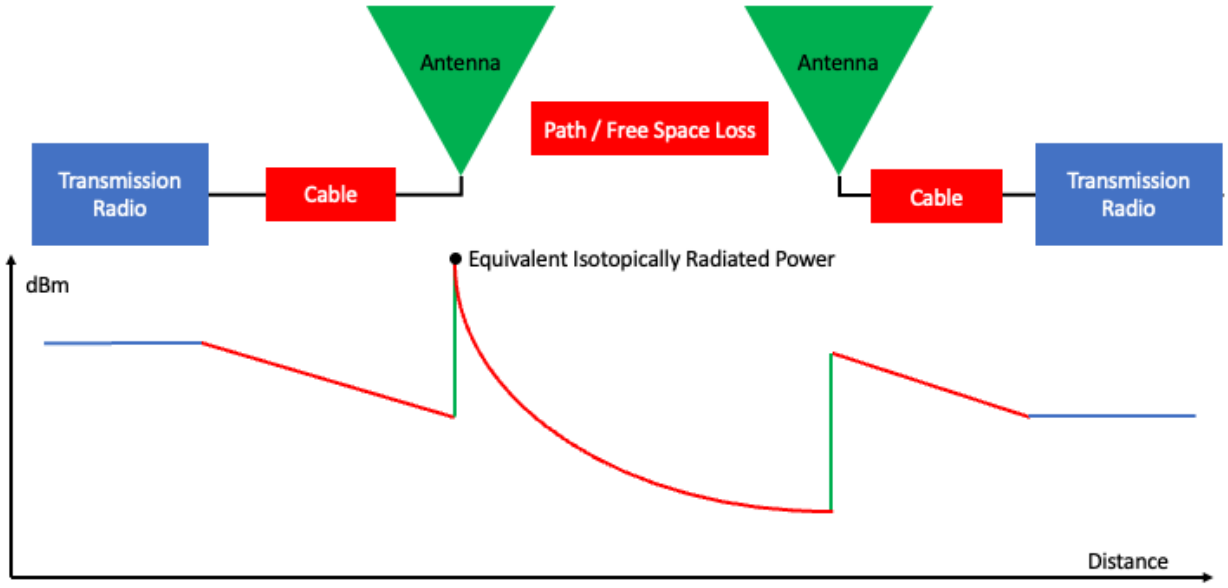

Figure 2: ASTRA Simplified Link Diagram